Digital Phosphor Oscilloscopes

MSO4000 Series, DPO4000 Series Data Sheet

Features & Benefits

Key Performance Specifications

- 1 GHz, 500 MHz, 350 MHz Bandwidth Models

- 2 and 4 Channel Models

- 16 Digital Channels (MSO4000)

- Sample Rates Up to 5 GS/s on All Channels

- 10 Megasample Record Length on All Channels

- 50,000 wfm/s Maximum Waveform Capture Rate

- Suite of Advanced Triggers

Ease of Use Features

- Wave Inspector® Controls Provide Unprecedented Efficiency in Waveform Analysis

- 10.4 in. (264 mm) XGA Color Display

- USB and CompactFlash on Front Panel for Quick and Easy Storage

- USB Plug-and-Play PC Connectivity

- Small Footprint and Lightweight – Only 5.4 in. (137 mm) deep and 11 lb. (5 kg)

- TekVPI® Probe Interface Supports Active, Differential, and Current Probes for Automatic Scaling and Units

Serial Triggering and Analysis

- Serial Triggering, Decode, and Analysis Options for I2C, SPI, RS-232/422/485/UART, I2S/LJ/RJ/TDM, CAN, LIN, and FlexRay

Additional Application Support

- Power Analysis Option

- HDTV and Custom Video Analysis Option

Mixed Signal Design and Analysis (MSO4000)

- Parallel Bus Trigger and Analysis

- MagniVu™ 60.6 ps Technology Provides Finer Timing Resolution

- Per-channel Threshold Settings

- Multichannel Setup and Hold Triggering

- Next-generation Digital Waveform Display

Applications

- Embedded Design and Debug

- Mixed Signal Design and Debug

- Investigation of Transient Phenomena

- Power Measurements

- Video Design and Debug

- Automotive Electronics Design and Debug

Tektronix®

MSO/DPO4000 Series Digital Phosphor Oscilloscopes

The DPO4000 Series Digital Phosphor Oscilloscopes (DPOs) are the first oscilloscopes to offer usable deep memory on all channels, excellent performance, serial trigger and analysis options, and all in the most compact form factor in their class. The MSO4000 Series Mixed Signal Oscilloscopes (MSOs) provide all the features and benefits of the DPO4000, but add 16 integrated digital channels, enabling you to visualize and correlate analog and digital signals on a single instrument. This integration extends triggering functionality across all 20 channels providing pattern and state triggering ideal for debugging mixed analog and digital designs.

Designed to Make Your Work Easier

As design complexity increases, you need tools that help you find problems quickly.

Easy to Setup and Use

The MSO/DPO4000 Series has a large 10.4 inch XGA display, a clean front panel with familiar knobs - all in a package that is only 5.4 in. deep and weighs only 11 lb. With USB plug-and-play operation and PC connectivity, acquiring data and measurements from the instrument is as simple as connecting a USB cable from the oscilloscope to the PC. Provided applications include NI LabVIEW SignalExpress™ Tektronix Edition LE, OpenChoice® Desktop and Microsoft Excel and Word toolbars enabling fast and easy direct communication with your Windows PC. USB and CompactFlash ports on the front panel enable simple transfer of screenshots, instrument settings, and waveform data in the palm of your hand.

When it comes to mixed signal design and debug, you want your instrument to be intuitive so you can start solving problems quickly. The MSO4000 Series drives like an oscilloscope, the tool you already know how to use. You do not have to relearn how to use the instrument every time you turn it on.

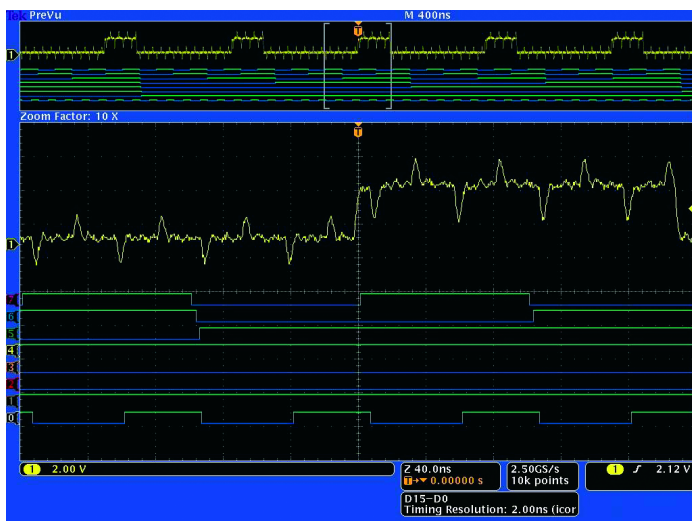### Wave Inspector® Navigation

Imagine trying to efficiently use the Internet if search engines such as Google and Yahoo didn't exist, web browser features such as Favorites and Links didn't exist, or Internet Service Providers like AOL or MSN weren't around. Now you know how most modern oscilloscope users feel when

Wave Inspector® controls.

trying to actually use the long record length in their digital oscilloscope. Record length, one of the key specifications of an oscilloscope, is the number of samples it can digitize and store in a single acquisition. The longer the record length, the longer the time window you can capture with high timing resolution (high sample rate).

The first digital oscilloscopes could capture and store only 500 points, which made it very difficult to acquire all relevant information around the event being investigated. Over the years, oscilloscope manufacturers have provided longer and longer record lengths to meet market demands for long capture windows with high resolution, to the point that most mid-range oscilloscopes either come standard with, or can be optionally upgraded to, multi-megapoint record lengths. These megapoint record lengths often represent thousands of screens worth of signal activity. While standard record lengths have increased greatly over the years and can now satisfy the vast majority of applications in the marketplace, tools for effectively and efficiently viewing, navigating, and analyzing long record length acquisitions have been sorely neglected until now.
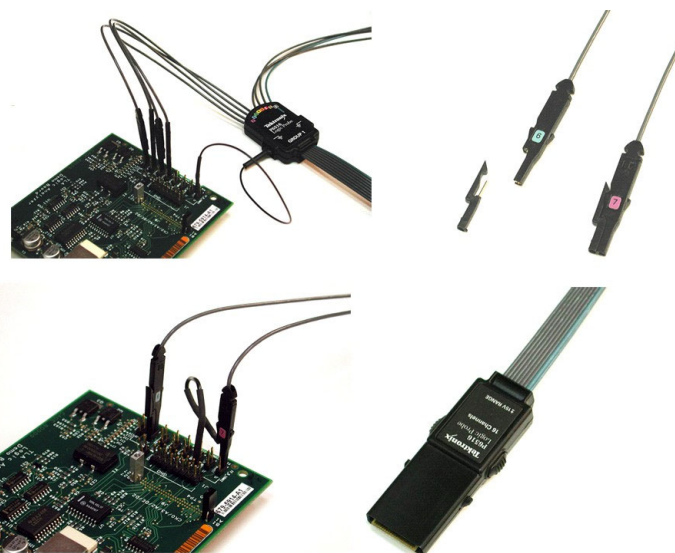
Wave Inspector® controls provide unprecedented efficiency in viewing, navigating, and analyzing waveform data.

P6516 Mixed-signal Oscilloscope probe.

The MSO/DPO4000 Series redefines expectations for working with long record lengths with the following innovative Wave Inspector controls:

Zoom/Pan – A dedicated, two-tier front-panel knob provides intuitive control of both zooming and panning. The inner knob adjusts the zoom factor (or zoom scale); turning it clockwise activates zoom and goes to progressively higher zoom factors, while turning it counterclockwise results in lower zoom factors and eventually turning zoom off. The outer knob pans the zoom box across the waveform to quickly get to the portion of the waveform you are interested in. The outer knob also utilizes force-feedback to determine how fast to pan on the waveform. The farther you turn the outer knob, the faster the zoom box moves. Pan direction is changed by simply turning the knob the other way. No longer do you need to navigate through multiple menus to adjust your zoom view.

Play/Pause – A dedicated **play/pause** button on the front panel scrolls the waveform across the display automatically while you look for anomalies or an event of interest. Playback speed and direction are controlled using the intuitive pan knob. Once again, turning the knob further makes the waveform scroll faster and changing direction is as simple as turning the knob the other way.

User Marks – See something interesting on your waveform? Press the **Set Mark** button on the front panel to leave one or more "bookmarks" on the waveform. Navigating between marks is as simple as pressing the **Previous** (←) and **Next** (→) buttons on the front panel.

Search Marks – Don't want to take the time to inspect the entire acquisition to find the event you're looking for? The MSO/DPO4000 Series features a robust waveform search feature that allows you to search through your long acquisition based on user-defined criteria. All occurrences of the event are highlighted with search marks and are easily navigated to, using the front panel **Previous** (←) and **Next** (→) buttons. Search types include edge, pulse width, runt, logic, setup and hold, rise/fall time and parallel, I2C, SPI, RS-232/422/485/UART, I2S/LJ/RJ/TDM, CAN, LIN, and FlexRay packet content.

P6516 MSO Probe

This unique probe design offers two eight-channel pods. Each channel ends with a new probe tip design that includes a recessed ground for simplified connection to the device-under-test. This sleek new probe simplifies the process of connecting to the device-under-test. The coax on the first channel of each pod is colored blue making it easy to identify. The common ground uses an automotive style connector making it easy to create custom grounds for connecting to the device-under-test. When connecting to square pins, the P6516 has an adapter that attaches to the probe head extending the probe ground flush with the probe tip so you can attach to a header. The P6516 offers outstanding electrical characteristics applying only 3 pF of loading.

Multichannel setup and hold triggering highlighting multiple violations (MSO4000).
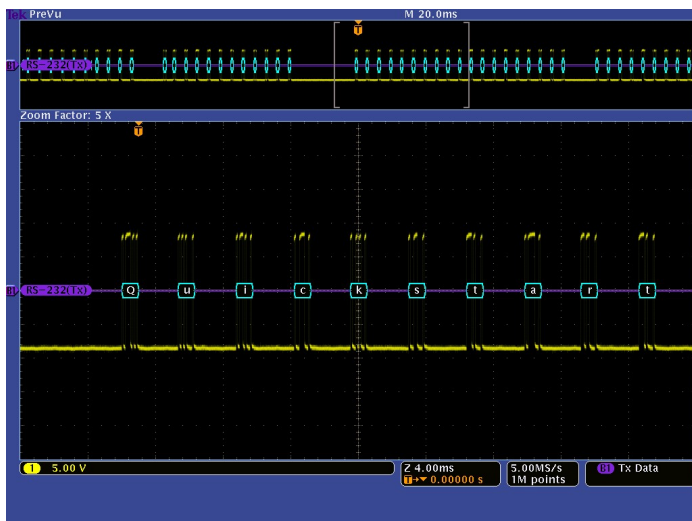
Triggering on a specific data packet going across an RS-232 bus. Bus waveform provides decoded packet content displayed in ASCII.

The Power to Solve Problems Quickly

The Performance and Feature Set You Expect

The MSO/DPO4000 Series Digital Phosphor Oscilloscopes (DPO) deliver the performance you need to visualize even your most demanding signals. Bandwidths range from 350 MHz to 1 GHz, and with all models offering a minimum of 5x oversampling on all channels and sin(x)/x interpolation standard, you can be confident that even the fastest transient events will be captured and displayed accurately. The standard 10 M record length on all channels enables you to capture long windows of signal activity while maintaining fine timing resolution.

The MSO/DPO4000 Series offers a variety of analytical solutions including cursors, 29 automatic measurements, statistics, and waveform math. Despite a tiny footprint (only 5.4 in. deep) and lightweight (11 lb.), the MSO/DPO4000 Series offers exceptional performance, a large 10.4 in. XGA display and knob-per-channel vertical controls.

The TekVPI™ probe interface sets the standard for ease of use in probing. TekVPI probes feature status indicators and controls, as well as a probe menu button right on the comp box itself. This button brings up a probe menu on the oscilloscope display with all relevant settings and controls for the probe. The TekVPI interface utilizes a new probe power management architecture enabling direct attachment of current probes without requiring a separate, bulky power supply. Finally, TekVPI probes can be controlled remotely using USB, GPIB, or Ethernet, enabling more versatile solutions in ATE environments.
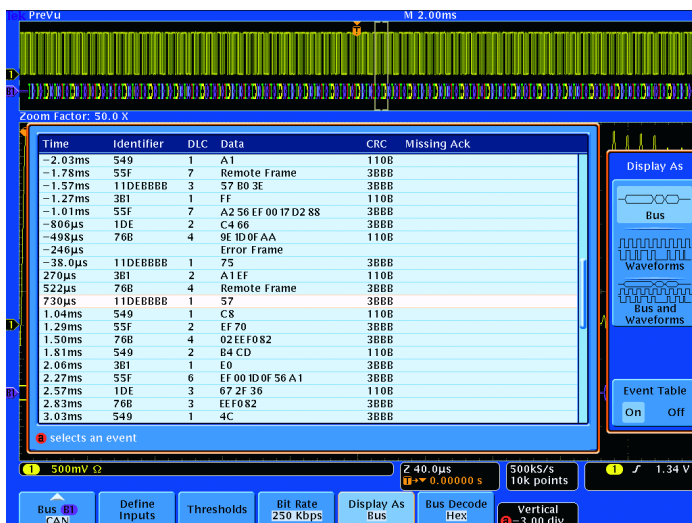
MagniVu™

The main digital acquisition mode on the MSO4000 Series will capture up to 10 M points at 500 MS/s (2 ns resolution). In addition to the main record, the MSO4000 Series provides an ultra high-resolution mode called MagniVu which acquires 10,000 points at up to 16.5 GS/s (60.6 ps resolution). Both main and MagniVu waveforms are acquired on every trigger and can be switched between at any time, running or stopped. MagniVu provides finer timing resolution than any other MSO on the market, instilling confidence when making critical timing measurements on digital waveforms.

Serial Triggering and Analysis

One of the most common applications requiring long record length is serial data analysis in embedded system design. Embedded systems are literally everywhere. They can contain many different types of devices including microprocessors, microcontrollers, DSPs, RAM, EPROMs, FPGAs, ADCs, DACs, and I/O. These various devices have traditionally communicated with each other and the outside world using wide parallel buses. Today, however, more and more embedded systems are replacing these wide parallel buses with serial buses due to lower board space requirements, fewer pins, lower power, embedded clocks, differential signaling for better noise immunity, and most importantly, lower cost. In addition, there's a large supply of off-the-shelf building block components from reputable manufacturers, enabling rapid design development.

While serial buses have a large number of benefits, they also present significant challenges that their predecessors (parallel buses) did not face. They make debugging bus and system problems more difficult, it's harder to isolate events of interest, and it's more difficult to interpret what is displayed on the oscilloscope screen. The MSO/DPO4000 Series addresses these

Time	Identifier	DLC	Data	CRC	Missing Ack
−2.03ms	549	1	A1	110B	
−1.78ms	55F	7	Remote Frame	3BBB	
−1.57ms	11DEBBBB	3	57 B0 3E	3BBB	
−1.27ms	3B1	1	FF	110B	
−1.01ms	55F	7	A2 56 EF 00 17 D2 88	3BBB	
−806µs	1DE	2	C4 66	3BBB	
−498µs	76B	4	9E 1D 0F AA	110B	
−246µs			Error Frame		
−38.0µs	11DEBBBB	1	75	3BBB	
270µs	3B1	2	A1 EF	110B	
522µs	76B	4	Remote Frame	3BBB	
730µs	11DEBBBB	1	57	3BBB	
1.04ms	549	1	C8	110B	
1.29ms	55F	2	EF 70	3BBB	
1.50ms	76B	4	02 EE F0 82	3BBB	
1.81ms	549	2	B4 CD	110B	
2.06ms	3B1	1	E0	3BBB	
2.27ms	55F	6	EF 00 1D 0F 56 A1	3BBB	
2.57ms	1DE	3	67 2F 36	110B	
2.83ms	76B	3	EE F0 82	3BBB	
3.03ms	549	1	4C	3BBB	

Packet decode table showing decoded Identifier, DLC, Data, and CRC for every CAN packet in a long acquisition.

challenges and represents the ultimate tool for engineers working with serial buses such as I2C, SPI, RS-232/422/485/UART, I2S/LJ/RJ/TDM, CAN, LIN and FlexRay.

Bus Display – Provides a higher level, combined view of the individual signals (clock, data, chip enable etc.) that make up your bus, making it easy to identify where packets begin and end and identifying subpacket components such as address, data, identifier, CRC etc.

Serial Triggering – Trigger on packet content such as start of packet, specific addresses, specific data content, unique identifiers, etc., on popular serial interfaces such as I2C, SPI, RS-232/422/485/UART, I2S/LJ/RJ/TDM, CAN, LIN and FlexRay.

Bus Decoding – Tired of having to visually inspect the waveform to count clocks, determine if each bit is a 1 or a 0, combine bits into bytes and determine the hex value? Let the oscilloscope do it for you! Once you've set up a bus, the oscilloscope will decode each packet on the bus, and display the value in either hex, binary, decimal (LIN and FlexRay only), signed decimal (I2S/LJ/RJ/TDM only), or ASCII (RS-232/422/485/UART only) in the bus waveform.

Event Table – In addition to seeing decoded packet data on the bus waveform itself, you can view all captured packets in a tabular view much like you would see on a logic analyzer. Packets are time stamped and listed consecutively with columns for each component (Address, Data, etc.).

Search – Serial triggering is very useful for isolating the event of interest, but once you've captured it and need to analyze the surrounding data, what do you do? In the past, you had to manually scroll through the waveform, counting and converting bits and looking for what caused the event. With the MSO/DPO4000 Series, you can have the oscilloscope search through the acquired data for user-defined criteria including serial packet content. Each occurrence is highlighted by a search mark. Rapid navigation between marks is as simple as pressing the **Previous** (←) and **Next** (→) buttons on the front panel.

## Mixed-Signal Design and Analysis (MSO4000)

As an embedded design engineer, you are faced with the challenge of ever-increasing system complexity. A typical embedded design may incorporate various analog signals, high- and low-speed serial digital communication, and microprocessor buses, just to name a few. Serial protocols such as I2C and SPI are used frequently for chip-to-chip communication, but parallel buses are still used in many applications. Microprocessors, FPGAs, Analog-to-Digital Converters (ADCs), and Digital-to-Analog Converters (DACs) are all examples of ICs that present unique measurement challenges in today's embedded designs. The MSO4000 Series Mixed-Signal Oscilloscopes offer the addition of 16 digital channels. These channels are tightly integrated into the oscilloscope's user interface, simplifying operation and making it possible to solve mixed signal issues more easily.

Next-generation Digital Waveform Display

In a continued effort to make mixed-signal oscilloscopes easy to use, the MSO4000 Series has redefined the way you view digital waveforms. One common problem shared by both logic analyzers and mixed-signal oscilloscopes is determining if data is a one or a zero when zoomed in far enough that the digital trace stays flat all the way across the display. The MSO4000 Series has color-coded the digital traces, displaying ones in green and zeros in blue.

The MSO4000 Series has multiple transition detection hardware. When the system detects multiple transitions, the user will see a white edge on the display. White edges indicate that more information is available by zooming in or acquiring at faster sampling rates. In most cases zooming in will reveal the pulse that was not viewable with the previous settings. If the white edge is still present after zooming in as far as possible, this indicates that increasing the sample rate on the next acquisition will reveal higher frequency information than the previous settings could acquire.

Channel setup on an MSO can often be time consuming as compared to the traditional oscilloscope. This process often includes probing the device-under-test, labeling the channels and positioning the channels on screen. The MSO4000 Series simplifies this process by allowing the user to group digital waveforms and enter waveform labels using a USB keyboard. By simply placing digital waveforms next to each other, they form a group. Once a group is formed, you can position all the channels contained in that group together. This greatly reduces the normal setup time associated with positioning channels individually.
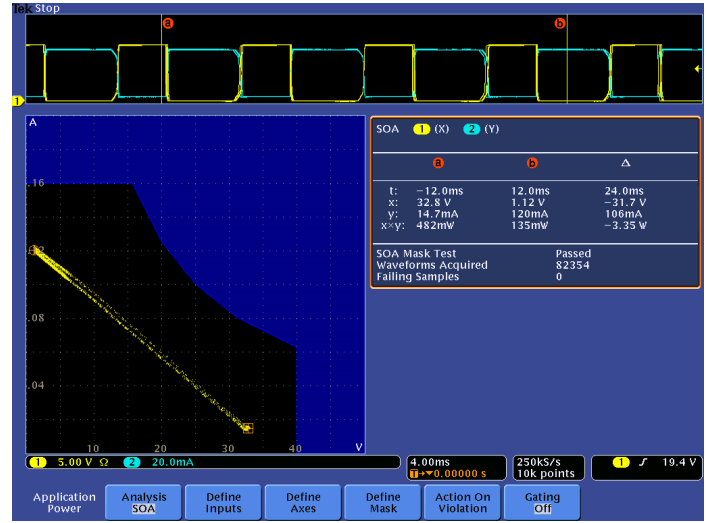
Data Sheet
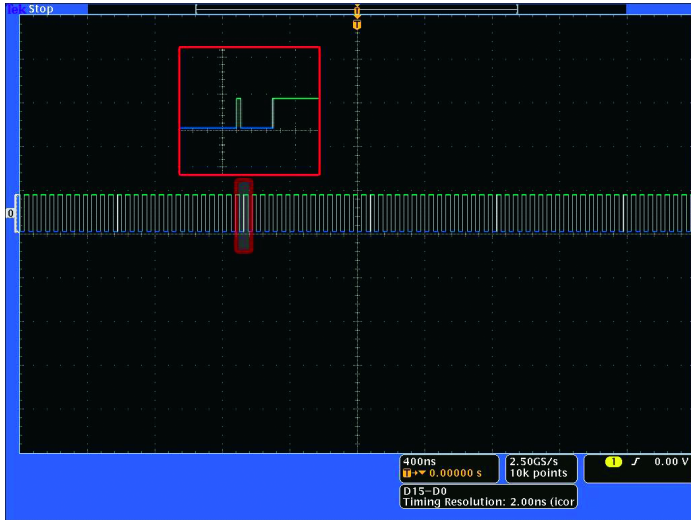
White edges indicate additional information is available by zooming in.
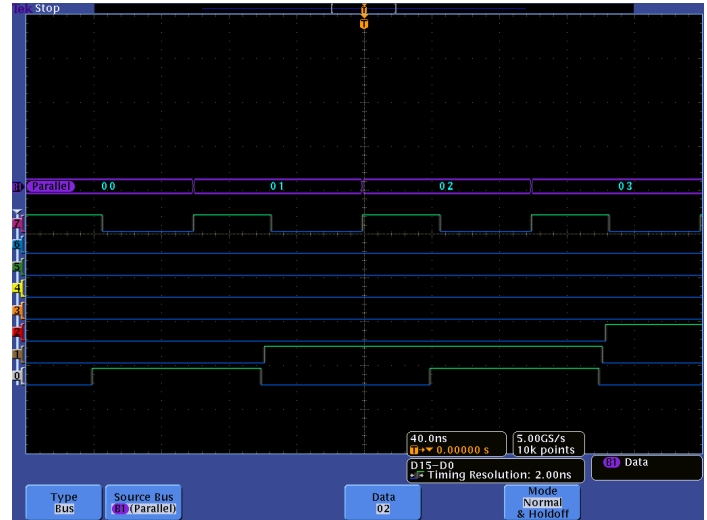
Clocked parallel bus display, decoding a 7 bit counter.
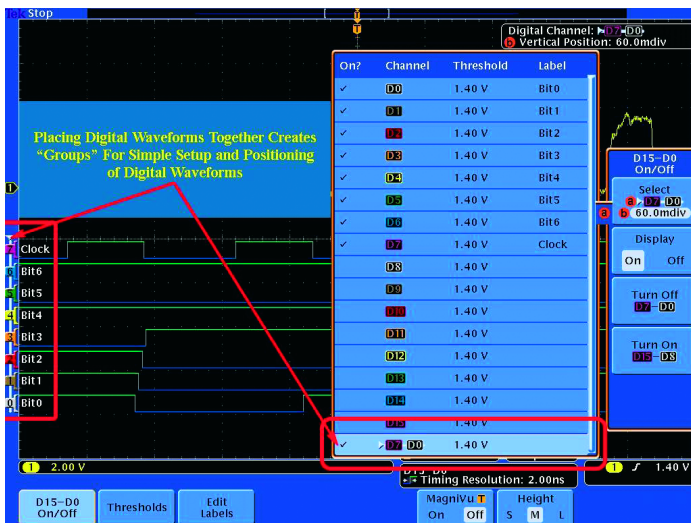
Groups are created by simply placing digital channels together on the screen. You can position and set threshold values for a group in a single step.


Safe operating area measurement. Automated power measurements enable quick and accurate analysis of common power parameters.

Additional Application Support

Power Analysis

Ever increasing consumer demand for longer battery life devices and for green solutions that consume less power, require power-supply designers to characterize and minimize switching losses to improve efficiency. In addition, the supply's power levels, output purity, and harmonic feedback into the power line must be characterized to comply with national and

regional power quality standards. Historically, making these and many other power measurements on an oscilloscope has been a long, manual, and tedious process. The DPO4PWR Power Analysis application module greatly simplifies these tasks, enabling quick and accurate analysis of power quality, switching loss, harmonics, safe operating area (SOA), modulation, ripple, and slew rate (dI/dt, dV/dt). Completely integrated into the oscilloscope, DPO4PWR provides automated power measurements with a touch of a button, no external PC or complex software setup is required.
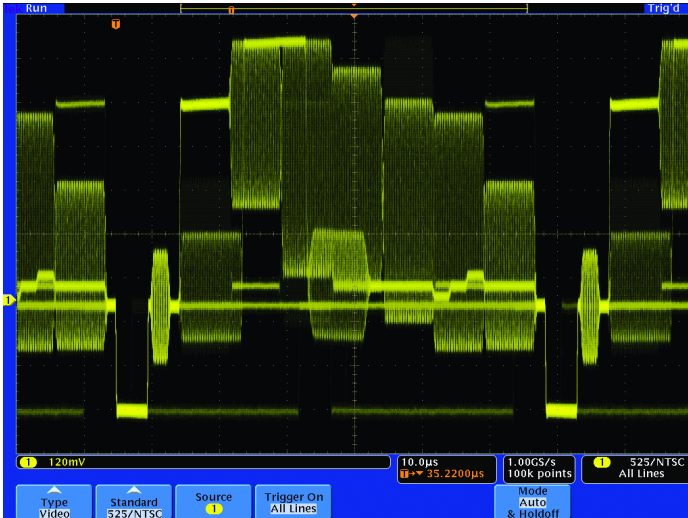
Viewing an NTSC video signal. Notice the intensity-graded view provided by the DPO's ability to represent time, amplitude, and distribution of amplitude over time.
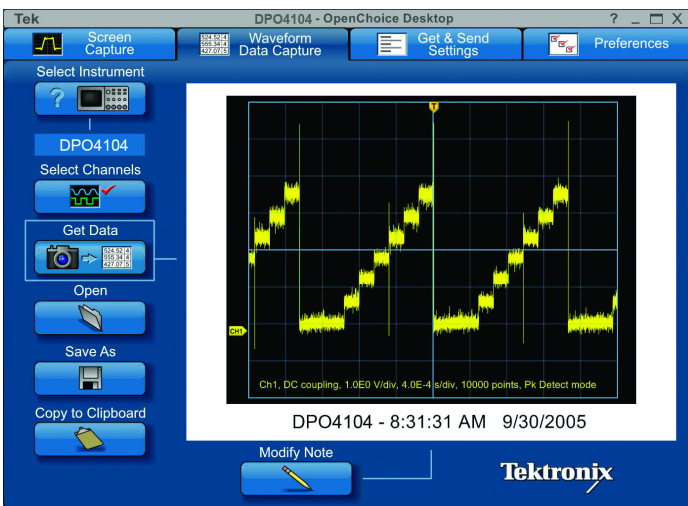

OpenChoice® Desktop – Standard software seamlessly connects the MSO/DPO4000 Series to a PC.

Video Design and Development

Many video engineers have remained loyal to analog oscilloscopes, believing the intensity gradations on an analog display are the only way to see certain video waveform details. The MSO/DPO4000 Series fast waveform capture rate, coupled with its intensity-graded view of the signal, provides the same information-rich display as an analog oscilloscope, but with much more detail and all the benefits of digital scopes.

Standard features such as IRE and mV graticules, holdoff by fields, video polarity, and an Autoset smart enough to detect video signals, make the MSO/DPO4000 Series the easiest to use oscilloscope on the market for video applications. And with up to 1 GHz bandwidth and four analog inputs,
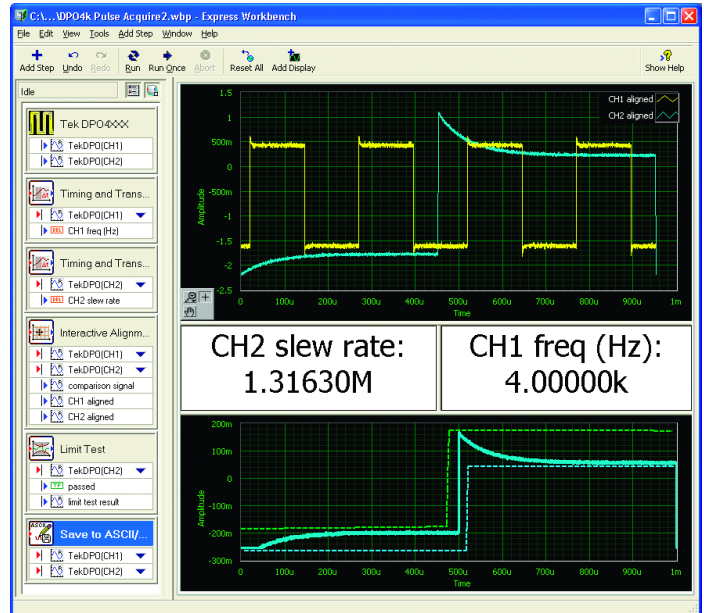
NI LabVIEW SignalExpress™ Tektronix Edition (SIGEXPTE) – Fully interactive measurement acquisition and analysis software developed jointly with NI, and optimized for the MSO/DPO4000 Series.
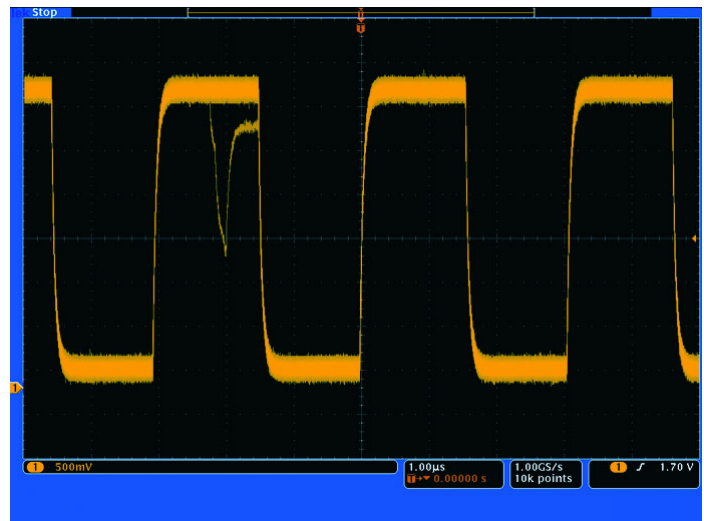
Fast waveform capture rate maximizes the probability of capturing elusive glitches and other infrequent events.

the MSO/DPO4000 Series provides ample performance for analog and digital video use.

Finally, the MSO/DPO4000 Series video functionality is further extended with the optional DPO4VID video application module. DPO4VID provides the industry's most complete suite of HDTV and custom (nonstandard) video triggers.

Characteristics

Vertical System Analog Channels

Characteristic	MSO4032	DPO4034 MSO4034	DPO4054 MSO4054	DPO4104 MSO4104
Input Channels	2	4	4	4
Analog Bandwidth (-3 dB) 5 mV/div - 1 V/div	350 MHz	350 MHz	500 MHz	1 GHz
Calculated Rise Time 5 mV/div (typical)	1 ns	1 ns	700 ps	350 ps
Hardware Bandwidth Limits	20 MHz or 250 MHz			
Input Coupling	AC, DC, GND			
Input Impedance	1 MΩ ±1%, 50 Ω ±1%			
Input Sensitivity, 1 MΩ	1 mV/div to 10 V/div			
Input Sensitivity, 50 Ω	1 mV/div to 1 V/div			
Vertical Resolution	8 bits (11 bits with Hi Res)			
Max Input Voltage, 1 MΩ	250 V_{RMS} with peaks ≤ ±400 V			
Max Input Voltage, 50 Ω	5 V_{RMS} with peaks < ±20 V			
DC Gain Accuracy	±1.5% with offset set to 0 V			
Offset Range	1 MΩ		50 Ω	
1 mV/div to 50 mV/div	±1 V		±1 V	
50.5 mV/div to 99.5 mV/div	±0.5 V		±0.5 V	
100 mV/div to 500 mV/div	±10 V		±10 V	
505 mV/div to 995 mV/div	±5 V		±5 V	
1 V/div to 5 V/div	±100 V		±5 V	
5.05 V/div to 10 V/div	±50 V		NA	
Channel-to-Channel Isolation	≥100:1 at ≤100 MHz and ≥30:1 at >100 MHz up to the rated bandwidth for any two channels having equal volts/div settings			

Vertical System Digital Channels

Characteristic	MSO4032	MSO4034	MSO4054	MSO4104
Input Channels	16 Digital (D15 - D0)			
Thresholds	Per-channel Thresholds			
Threshold Selections	TTL, CMOS, ECL, PECL, User Defined			
User-defined Threshold Range	+5 to -2 V			
Maximum Input Voltage	±15 V			
Threshold Accuracy	±(100 mV + 3% of threshold setting)			
Input Dynamic Range	6 V_{p-p} centered around the threshold			
Minimum Voltage Swing	500 mV			
Input Impedance	20 kΩ			
Probe Loading	3 pF			
Vertical Resolution	1 bit			

Horizontal System Analog Channels

Characteristic	MSO4032	DPO4034 MSO4034	DPO4054 MSO4054	DPO4104 MSO4104
Maximum Sample Rate (all channels)	2.5 GS/s	2.5 GS/s	2.5 GS/s	5 GS/s
Minimum Peak Detect Pulse Width	400 ps			200 ps
Maximum Record Length (all channels)	10 M points			
Maximum Duration at Highest Sample Rate (all channels)	4 ms	4 ms	4 ms	2 ms
Timebase Range	1 ns to 1,000 s			400 ps to 1,000 s
Timebase Delay Time Range	-10 divisions to 5000 s			
Channel-to-Channel Deskew Range	±100 ns			
Timebase Accuracy	±5 ppm over any ≥ 1 ms interval			

Horizontal System Digital Channels

Characteristic	MSO4032	MSO4034	MSO4054	MSO4104
Maximum Sample Rate (Main)	500 MS/s (2 ns resolution)			
Maximum Record Length (Main)	10 M points			
Maximum Sample Rate (MagniVu)	16.5 GS/s (60.6 ps resolution)			
Maximum Record Length (MagniVu)	10 k points centered around the trigger			
Minimum Detectable Pulse Width	1.5 ns			
Channel-to-Channel Skew	60 ps typical			

Trigger System

Characteristic	Description
Main Trigger Modes	Auto, Normal, and Single
Trigger Coupling	DC, HF reject (attenuates >50 kHz), LF reject (attenuates <50 kHz), noise reject (reduces sensitivity)
Trigger Holdoff Range	20 ns to 8 s
Trigger Frequency Readout	6-digit hardware counter indicates how often triggerable events are occurring in the user's signal.

Sensitivity

Internal DC Coupled	0.4 div DC to 50 MHz, increasing to 1 div at rated bandwidth
External (Auxiliary Input)	200 mV from DC to 50 MHz increasing to 500 mV at 250 MHz

Trigger Level Range

Any Channel	±8 divisions from center of screen
External (auxiliary input)	±8 V

Trigger Modes

Edge	Positive or negative slope on any channel or front-panel auxiliary input. Coupling includes DC, HF reject, LF reject, and noise reject.
Sequence (B-trigger)	Trigger Delay by Time - 4 ns to 8 s. Or Trigger Delay by Events - 1 to 9,999,999 events.
Pulse Width	Trigger on width of positive or negative pulses that are >, <, =, or ≠ a specified period of time.
Runt	Trigger on a pulse that crosses one threshold but fails to cross a second threshold before crossing the first again.
Logic	Trigger when any logical pattern of channels goes false or stays true for specified period of time. Any input can be used as a clock to look for the pattern on a clock edge. Pattern (AND, OR, NAND, NOR) specified for all analog and digital input channels defined as High, Low, or Don't Care.
Setup and Hold	Trigger on violations of setup time and/or hold time between clock and data present on any of the input channels.
Rise/Fall Time	Trigger on pulse edge rates that are faster or slower than specified. Slope may be positive, negative, or either.
Video	Trigger on line number, all lines, odd, even, or all fields on NTSC, PAL, and SECAM video signals.
Extended Video (optional)	Trigger on 480p/60, 576p/50, 720p/30, 720p/50, 720p/60, 875i/60, 1080i/50, 1080i/60, 1080p/24, 1080p/24sF, 1080p/25, 1080p/30, 1080p/50, 1080p/60, and custom bilevel and trilevel sync video standards.
I2C (Optional)	Trigger on Start, Repeated Start, Stop, Missing ACK, Address (7 or 10 bit), Data, or Address and Data on I2C buses up to 3.4 Mbps.
SPI (Optional)	Trigger on SS, Idle Time, MOSI, MISO, or MOSI and MISO on SPI buses up to 10.0 Mbps.
CAN (Optional)	Trigger on Start of Frame, Frame Type (data, remote, error, overload), Identifier (standard or extended), Data, Identifier and Data, End of Frame, Missing ACK, or Bit Stuffing Errors on CAN signals up to 1 Mbps. Data can be further specified to trigger on ≤, <, =, >, ≥, or ≠ a specific data value. User-adjustable sample point is set to 50% by default.
I2S/LJ/RJ/TDM (Optional)	Trigger on Word Select, Frame Sync, or Data. Data can be further specified to trigger on ≤, <, =, >, ≥, ≠ a specific data value, or inside or outside of a range.
RS-232/422/485/UART (Optional)	Trigger on Tx start bit, Rx start bit, Tx end of packet, Rx end of packet, Tx data, Rx data, Tx Parity Error, and Rx Parity Error.
LIN (Optional)	Trigger on Sync, Identifier, Data, Identifier and Data, Wakeup Frame, Sleep Frame, or Errors such as Sync, Parity, or Checksum Errors.
FlexRay (Optional)	Trigger on Start of Frame, Type of Frame (Normal, Payload, Null, Sync, Startup), Identifier, Cycle Count, Complete Header Field, Data, Identifier and Data, End of Frame or Errors such as Header CRC, Trailer CRC, Null Frame, Sync Frame, or Startup Frame Errors
Parallel (available on MSO models only)	Trigger on a parallel bus data value.

Acquisition Modes

Mode	Description
Sample	Acquires sampled values
Peak Detect	Captures glitches as narrow as 200 ps at all sweep speeds
Averaging	From 2 to 512 waveforms included in average
Envelope	Min-max envelope reflecting Peak Detect data over multiple acquisitions
Hi Res	Real-time boxcar averaging reduces random noise and increases vertical resolution
Roll	Scrolls waveforms right to left across screen at sweep speeds slower than or equal to 40 ms/div

Waveform Measurements

Characteristic	Description
Cursors	Waveform and Screen
Automatic Measurements	29, of which up to eight can be displayed on screen at any one time. Measurements include Period, Frequency, Delay, Rise Time, Fall Time, Positive Duty Cycle, Negative Duty Cycle, Positive Pulse Width, Negative Pulse Width, Burst Width, Phase, Positive Overshoot, Negative Overshoot, Peak to Peak, Amplitude, High, Low, Max, Min, Mean, Cycle Mean, RMS, Cycle RMS, Positive Pulse Count, Negative Pulse Count, Rising Edge Count, Falling Edge Count, Area, and Cycle Area.
Measurement Statistics	Mean, Min, Max, Standard Deviation
Reference Levels	User-definable reference levels for automatic measurements can be specified in either percent or units
Gating	Isolate the specific occurrence within an acquisition to take measurements, using either the screen or waveform cursors

Power Measurements (optional)

Characteristic	Description
Power Quality Measurements	V_{RMS}, $V_{Crest\ Factor}$, Frequency, I_{RMS}, $I_{Crest\ Factor}$, True Power, Apparent Power, Reactive Power, Power Factor, Phase Angle
Switching Loss Measurements	Power Loss: T_{on}, T_{off}, Conduction, Total
	Energy Loss: T_{on}, T_{off}, Conduction, Total
Harmonics	THD-F, THD-R, RMS measurements
	Graphical and table displays of harmonics
	Test to IEC61000-3-2 Class A and MIL-STD-1399
Ripple Measurements	V_{ripple} and I_{ripple}
Modulation Analysis	Graphical display of +Pulse Width, -Pulse Width, Period, Frequency, +Duty Cycle, and -Duty Cycle modulation types
Safe Operating Area	Graphical display and mask testing of switching device safe operating area measurements
dV/dt and dI/dt Measurements	Cursor measurements of slew rate

Waveform Math

Characteristic	Description
Arithmetic	Add, subtract, multiply, and divide waveforms
Math Functions	Integrate, Differentiate, FFT
FFT	Spectral magnitude. Set FFT Vertical Scale to Linear RMS or dBV RMS, and FFT Window to Rectangular, Hamming, Hanning, or Blackman-Harris.
Advanced Math	Define extensive algebraic expressions including analog waveforms, math functions, scalars, up to two user-adjustable variables, and results of parametric measurements (both static and trend plots) e.g., (Intg (Ch1–Mean(Ch1)) × 1.414 × VAR1).

Software

Software	Description
NI LabVIEW SignalExpress Tektronix Edition LE	A fully interactive measurement software environment optimized for the MSO/DPO4000 Series, enables you to instantly acquire, generate, analyze, compare, import, and save measurement data and signals using an intuitive drag-and-drop user interface that does not require any programming. Standard MSO/DPO4000 Series support for acquiring, controlling, viewing, and exporting your live signal data is permanently available through the software. The full version (SIGEXPTE) adds additional signal processing, advanced analysis, mixed signal, sweeping, limit testing, and user-defined step capabilities and is available for a 30-day trial period standard with each instrument.
OpenChoice® Desktop	Enables fast and easy communication between a Windows PC and the MSO/DPO4000 Series, using USB or LAN. Transfer and save settings, waveforms, measurements, and screen images.
IVI Driver	Provides a standard instrument programming interface for common applications such as LabVIEW, LabWindows/CVI, Microsoft .NET and MATLAB.

Display Characteristics

Characteristic	Description
Display Type	10.4 in. (264 mm) liquid-crystal TFT color display
Display Resolution	1,024 horizontal × 768 vertical pixels (XGA)
Waveform Styles	Vectors, Dots, Variable Persistence, Infinite Persistence
Graticules	Full, Grid, Cross Hair, Frame, IRE, and mV
Format	YT and simultaneous XY/YT
Waveform Capture Rate	Up to 50,000 wfms/sec

Input/Output Ports

Port	Description
CompactFlash Drive	Front-panel access (Type 1)
USB 2.0 Full-speed Host Port	Supports USB mass storage devices, printers and keyboard. Two ports available on rear panel and one on front panel.
USB 2.0 High-speed Device Port	Rear-panel connector allows for control of oscilloscope through USBTMC or GPIB with a TEK-USB-488 or connection to a PictBridge printer.
LAN Port	RJ-45 connector, supports 10/100Base-T
XGA Video Port	DB-15 female connector, connect to show the oscilloscope display on an external monitor or projector
Auxiliary Input	Front-panel BNC connector. Input Impedance 1 MΩ. Max input 250 V_{RMS} with peaks ±400 V.
Probe Compensator Output	Front-panel pins Amplitude 2.5 V Frequency 1 kHz
Trigger Out	Rear-panel BNC connector, provides a positive polarity pulse when the oscilloscope triggers
Kensington Lock	Rear-panel security slot connects to standard Kensington lock

Power Source

Characteristic	Description
Power Source Voltage	100 to 240 V ±10%
Power Source Frequency	47 to 66 Hz (90 to 264 V) 360 to 440 Hz (100 to 132 V)
Power Consumption	250 W maximum

Physical Characteristics

Dimensions	mm	in.
Height	229	9.0
Width	439	17.3
Depth	137	5.4

Weight	kg	lb.
Net	5	11
Shipping	9.5	22

Rackmount Configuration	5U	
Cooling Clearance	2 in. (51 mm) required on left side and rear of instrument	

General Characteristics

Characteristic	Description
Environmental	
Temperature	
Operating	0 ℃ to +50 ℃
Nonoperating	-20 ℃ to +60 ℃
Humidity	
Operating	High: 40 ℃ to 50 ℃, 10% to 60% Relative Humidity
	Low: 0 ℃ to 40 ℃, 10% to 90% Relative Humidity
Nonoperating	High: 40 ℃ to 60 ℃, 5% to 60% Relative Humidity
	Low: 0 ℃ to 40 ℃, 5% to 90% Relative Humidity
Altitude	
Operating	3,000 meters (9,843 feet)
Nonoperating	12,000 meters (39,370 feet)
Random Vibration	
Operating	0.31 G_{RMS} from 5 to 500 Hz, 10 minutes each axis, 3 axes, 30 minutes total
Nonoperating	2.46 G_{RMS} from 5 to 500 Hz, 10 minutes each axis, 3 axes, 30 minutes total
Regulatory	
Electromagnetic Compatibility	89/336/EEC
Safety	UL61010-1, Second Edition; CSA61010-1 Second Edition, EN61010-1:2001; IEC 61010-1:2001

Ordering Information

MSO/DPO4000 Family

Model	Description
DPO4000 Models	
DPO4034	350 MHz, 2.5 GS/s, 10 M record length, 4-channel digital phosphor oscilloscope
DPO4054	500 MHz, 2.5 GS/s, 10 M record length, 4-channel digital phosphor oscilloscope
DPO4104	1 GHz, 5 GS/s, 10 M record length, 4-channel digital phosphor oscilloscope
MSO4000 Models	
MSO4032	350 MHz, 2.5 GS/s, 10 M record length, 2+16 channel mixed-signal oscilloscope
MSO4034	350 MHz, 2.5 GS/s, 10 M record length, 4+16 channel mixed-signal oscilloscope
MSO4054	500 MHz, 2.5 GS/s, 10 M record length, 4+16 channel mixed-signal oscilloscope
MSO4104	1 GHz, 5 GS/s, 10 M record length, 4+16 channel mixed-signal oscilloscope

All models include: One P6139A 500 MHz, 10x Passive Probe per Analog Channel, Front Cover (200-4908-00), CompactFlash Memory Card; ≥32 MB (156-9413-00), User Manual (071-2121-xx), Documentation CD (063-3903-00), OpenChoice® Desktop Software, NI LabVIEW SignalExpress™ Tektronix Edition LE Software, Calibration certificates document measurement traceability to National Metrology

Institute(s) - the Quality System this product is manufactured in is ISO9001 registered, power cord, accessory bag (016-1967-00) and a three-year warranty. Please specify power plug and manual version when ordering. MSO models also include one P6516 16-channel logic probe and a logic probe accessory kit (020-2662-00).

Application Modules

Module	Description
DPO4EMBD	Embedded Serial Triggering and Analysis Module. Enables triggering on packet level information on I^2C and SPI buses as well as analytical tools such as digital views of the signal, bus views, packet decoding, search tools, and packet decode tables with time stamp information.
DPO4COMP	Computer Serial Triggering and Analysis Module. Enables triggering on packet level information on RS-232/422/485/UART buses as well as analytical tools such as digital views of the signal, bus views, packet decoding, search tools, and packet decode tables with time stamp information.
DPO4AUDIO	Audio Serial Triggering and Analysis Module. Enables triggering on packet level information on I^2S, LJ, RJ, and TDM audio buses as well as analytical tools such as digital views of the signal, bus views, packet decoding, search tools, and packet decode tables with time stamp information.
DPO4AUTO	Automotive Serial Triggering and Analysis Module. Enables triggering on packet level information on CAN and LIN buses as well as analytical tools such as digital views of the signal, bus views, packet decoding, search tools, and packet decode tables with time stamp information.
DPO4AUTOMAX	Extended Automotive Serial Triggering and Analysis Module. Enables triggering on packet level information on CAN, LIN and FlexRay buses as well as analytical tools such as digital views of the signal, bus views, packet decoding, search tools, packet decode tables with time stamp information, and eye-diagram analysis software.
DPO4PWR	Power Analysis Application Module. Enables quick and accurate analysis of power quality, switching loss, harmonics, safe operating area (SOA), modulation, ripple, and slew rate (dI/dt, dV/dt).
DPO4VID	HDTV and Custom (nonstandard) Video Triggering Module.

Instrument Options

Power Plug Options

Option	Description
Opt. A0	North America
Opt. A1	Universal Euro
Opt. A2	United Kingdom
Opt. A3	Australia
Opt. A5	Switzerland
Opt. A6	Japan
Opt. A10	China
Opt. A11	India
Opt. A99	No power cord or AC adapter

Language Options*1

Option	Description
Opt. L0	English manual
Opt. L1	French manual
Opt. L2	Italian manual
Opt. L3	German manual
Opt. L4	Spanish manual
Opt. L5	Japanese manual
Opt. L6	Portuguese manual
Opt. L7	Simplified Chinese manual
Opt. L8	Standard Chinese manual
Opt. L9	Korean manual
Opt. L10	Russian manual
Opt. L99	No manual

*1 Language options include a translated front-panel overlay for the selected language(s).

Service Options*2

Option	Description
Opt. C3	Calibration Service 3 years
Opt. C5	Calibration Service 5 years
Opt. CA1	Provides a single calibration event, or coverage for the designated calibration interval, whichever comes first.
Opt. D1	Calibration Data Report
Opt. D3	Calibration Data Report 3 years (with Opt. C3)
Opt. D5	Calibration Data Report 5 Years (with Opt. C5)
Opt. R5	Repair Service 5 years (including warranty)

*2 Probes and accessories are not covered by the oscilloscope warranty and service offerings. Refer to the datasheet of each probe and accessory model for its unique warranty and calibration terms.

Recommended Probes

Probe	Description
TAP1500	1.5 GHz TekVPI™ active probe
TAP1500X2	Bundle of Two 1.5 GHz Active Probes, single-ended with TekVPI Interface; Certificate of traceable calibration standard
TDP0500	500 MHz TekVPI 42 V differential probe
TDP1000	1 GHz TekVPI 42 V differential probe
TCP0030	120 MHz TekVPI 30 Ampere AC/DC current probe
TCP0150	20 MHz TekVPI 150 Ampere AC/DC current probe
TCPA300/400*3	Current measurement systems
P5200	1.3 kV, 25 MHz high-voltage differential probe
P5205*3	1.3 kV, 100 MHz high-voltage differential probe
P5210*3	5.6 kV, 50 MHz high-voltage differential probe
P5100	2.5 kV, 100X high-voltage passive probe
ADA400A*3	100X, 10X, 1X, 0.1X high-gain differential amplifier
NEX-HD2HEADER	Mictor connector breakout to 0.1 in. header pins
DPO4PWRBND Power Solution Bundle	Includes P5205 and TDP0500 differential voltage probes, TCP0030 current probe, TPA-BNC adapter, deskew pulse generator (TEK-DPG), deskew fixture, and power analysis module (DPO4PWR) in a hard-sided carrying case. Bundle discount reflected in price.

*3 Requires TekVPI™ to TekProbe BNC adapter (TPA-BNC).

Recommended Accessories

Accessory	Description
071-1844-XX	Service Manual (English only)
SIGEXPTE	NI LabVIEW SignalExpress™ Tektronix Edition Software (Full Version)
FPGAView-xx	MSO Support for Altera and Xilinx FPGAs
TPA-BNC	TekVPI to TekProbe BNC Adapter
TEK-USB-488	GPIB to USB Adapter
TLAHRA with (2) 196-3476-01	High-impedance Adapter and Leadsets for P6516 MSO Probe
119-6827-00	CompactFlash to USB Memory Card Reader
ACD4000	Soft Transit Case
HCTEK4321	Hard Transit Case (Requires ACD4000)
RM4000	Rackmount Kit
AMT75*3	1 GHz, 75 Ω Adapter
TEK-DPG	Deskew Pulse Generator
067-1686-00	Deskew Fixture

*3 Requires TekVPI™ to TekProbe BNC adapter (TPA-BNC).

Warranty
Three-year warranty covering all parts and labor, excluding probes.

CE

ISO 9001 — Product(s) are manufactured in ISO registered facilities.

GPIB IEEE-488 — Product(s) complies with IEEE Standard 488.1-1987, RS-232-C, and with Tektronix Standard Codes and Formats.

For Further Information. Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit **www.tektronix.com**

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